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macrospore, largely by chance, in a large volume of water, hence a great number of microspores must be produced.

In the case of the metazoa conjugation is always secured by the fertilization of a macrospore (ovum) by a microspore (spermatozoon). When the former is utilized as a storehouse for nutriment (yolk or deuteroplasm) for the developing embryo, the size (as in the case of the hen's egg) becomes relatively enormous, but the amounts of idioplasm that unite are approximately equal, and represent in each case all the characters of the species, including those that are peculiar to each sex. That conjugation is not an absolutely necessary occurrence is shown by the fact that if it is prevented the egg often develops as if it had occurred, and in many instances parthenogenesis is normal, as in the plant lice; and furthermore, in some of the lowest plants, where the embryo is very simple and does not require the large store of deuteroplasm, even spermatie parthenogenesis occurs, especially in the case of microspores of the algæ.

Thus we are excluded from the hypothesis that there are two sorts of protoplasm, the union of which, is needful for life. But what is the significance of conjugation (or fertilization)? Evidently the idioplasms of the two cells have had different experiences. The chances are that many cells have "gone to the ground" while this experience has been acquired, and that if each cell before conjugation had to encounter the trials the other has surmounted, it might succumb. How easy to unite the two experiences and enlarge the life. "Two heads are wiser than one," is the law even among the protozoa. Hermaphroditism is usual with sessile organisms like mollusks and baracles; and is understood to be an adaptation to a fixed condition, mutual fertilization being advantageous. When the ova are fertilized while yet in the body and the spermatozoa are conveyed to them the production of a smaller number of fertilizing cells is required. A further advance is possible by substituting for a large yolk, the uterine gestation of the embryo. These advances cause the acquirement of special organs that become the external signs of sexual differentiation, both psychological and physiological. To apply the idea of sex to the cells is misleading. Even the human embryo is hermaphrodite (properly non-sexed), and rudiments of the organs of the opposite sex are present in all animals. In cases of monstrosities these rudiments suffer more or less of development as may be seen by consulting "*L'hermaphrodisme*" by Debierre.

If sex is caused by secondarily acting extraneous forces, it becomes an important inquiry to investigate what such forces are, and how they act. This has been done in the most able manner by the following author.

*Die Regulierung des Geschlechtsverhältnisses bei Vermehrung der Menschen, Tiere und Pflanzen.* DÜSING. Jena, 1884, pp. 364.

There appears to be a fixed ratio between the number of male and female births which in many instances approaches equality. For man this ratio is 106 boys to 100 girls. What circumstances cause this ratio to vary? The reproductive organs are very sensitive to variations in the amount of food, and it is of advantage to a species to accommodate the number of offspring to the supply of food available. The number of offspring depends primarily on the number of females, hence there must exist an association between the tendency to the production of ova and the fact of increased food supply if any regulation of this sort is present. Facts show that such is the case. In general terms the law may be stated thus: good nutrition and moderate exercise of the reproductive organs produces a tendency to the production of females, while poor nutrition and excessive exercise of these organs produces a tendency to the production of males. The eggs of the queen bee receiving

an accession of strength through fertilization develop into females. During development a special feeding of the larva produces a complete female or queen; a poorer feeding produces incomplete females or workers. The development of males only from unfertilized eggs is known as *arrenotoky*. In the more ordinary forms of parthenogenesis exhibited by plant lice the production of males drops out altogether, and unfertilized eggs produce females only, this is known as *thelytoky*; and it arises through the easy conditions of nutrition brought about by a parasitic life. Parasites are remarkably fertile in eggs, and usually, also, parthenogenetic, *i. e.*, reproduce by *agamogenesis*. (Sexual reproduction is termed *gamogenesis*). The male has been termed the "hunger generation," arising either exclusively or in increased numbers when the conditions of life become hard. This may explain the excessive mortality of male infants both before and after delivery. The male embryo is a higher development than the female and requires better conditions, yet paradoxically, is produced under unfavorable conditions. In *gamogenesis* we have two degrees: favorable conditions producing females and unfavorable ones males; but *gamogenesis* itself arises under relatively unfavorable conditions, while parthenogenesis on the one hand, or simple cell multiplication (resulting in growth in multicellular animals and asexual reproduction in protozoa) on the other, arises under the most favorable conditions. Thus it results that in animals that multiply exclusively by *gamogenesis*, as does man, that plethora produces sterility, and the change merely from an animal to a vegetable diet has cured it. The poor have large families. It would be interesting to group the working classes into the "comfortable" and the "very poor," and compare the sexual ratio. It may almost confidently be predicted that the male excess will be greater and the number of children per marriage less with the very poor than with the moderately poor. In a general way increased nutrition tends to increase reproduction at the same time that it favors female births. Temperature affects reproduction by acting on nutrition, less energy for maintaining the body temperature being required in high temperatures. Haycraft has shown that a rise of 1° effects a rise of five per cent. in the births. The yearly curve of the birth rate is highest in summer and lowest in winter, the maximum and minimum points are at the beginning of these seasons (as respects the climate, not astronomical seasons), in June and October respectively. A series of curves for a long succession of years representing the variations in the harvests, the marriages, the births, the living births, the ratio of girls to boys (and inversely of boys to girls) are all parallel. There is always a rise in the male births after a war.

Another phase of the same fact is known as "Thury's law," which is, that *young reproductive cells tend to produce the same sex, and old ones to produce the opposite, e. g.*, if animals are paired so that the male is in the beginning of heat and the female is near the close of heat, the forces from both parents tend towards male offspring. The "Hofaker-Sadler law" is still another phase of this same principle (that delayed conception of the female tends towards male offspring), applied to the relative ages of the parents, as based on statistics of the age of the wife at the time of the first child, compared with the age of the husband, *e. g.*, the wife older than the husband, or relatively old when married, tends to produce male offspring.

Düsing would regroup the statistics and modify the form of the law as follows: Each sex at the time of its highest reproductive vigor tends to produce the opposite; and variations in both directions, either younger or older, are unfavorable to reproductive activity. First-births are excessively boys, due to the relatively higher continence of the female. The strength of crossing, as compared with in-breeding, is favorable to the production of females. This explains why the excess

of boys is greater in the country than in cities. The variety of conditions of life acts in a manner similar to the effects of crossing, while the monotony of country life co-operates with the scarcity of new blood toward the opposite effect. Legitimate children are to a greater extent males than illegitimate ones. This is explained by the fact that marriage tends to obliterate differences between the partners. The very hereditary principle or idioplasm of the female is so profoundly assimilated to that of the male, that the children by a second husband partake of the characteristics of the first, a law well known to stock breeders. This is a fact that no theory of heredity has yet tried to explain.

Here we are tempted into a digression. If the character may be modified by circumstances, so that conditions of life may replace crossing, as when an organism transplanted to new countries multiplies (often asexually) with extreme vigor, may it not be well to investigate what effect associations of the parent may have upon the character of the child. The whole subject of the effect of the life activities of the mother on, not alone the nutrition of the child, but upon its idioplasm, is as legitimate an inquiry as the effect of such conditions on the ovum before or during fertilization. Neither inquiry has as yet been handled with sufficient scientific skill to warrant positive statements. The belief that the imagination of the mother may mark her child in a definite manner, is universally held by unscientific people, or such as are not informed of the results of scientific investigation in this direction; but these experiments (like Galton's experiments to disprove pangenesis) are too meagre, and of simply negative nature. The subject is one so complex, that a renewed investigation with enlarged methods is required. The questions here raised suggest a connection with telepathy or sympathetic psychic response—a subject not yet properly investigated by either friend or foe—as do also the phenomena of sexual attraction.

Returning to Düsing from this digression—the most powerful factors determining sex are those acting on the reproductive cells, but it frequently happens that the algebraic summation of these leaves the ovum so near equilibrium that subsequent forces acting on the embryo determine the sex. Hence the reason of the prolonged hermaphroditism of the embryo, that all the forces may be summated. It is found that twins are generally of the same sex, because of the similarity of the nutritive conditions. *Multiparae* are a general evidence of vigor, and hence show an excess of girls for twins, but for numbers higher than triplets the nutrition of each embryo is correspondingly limited, and here a great excess of boys occurs. In thelytoky, where the approach of winter causes males to appear, as *e. g.*, in *Cladocera*, the males appear gradually, and some are hermaphrodite. Sometimes insects are found in which different sectors of the body are of different sex. This may be explained by opposing tendencies of the idioplasms of the parents, (one tending toward female, the other toward male production), and an incomplete mixture of the two in fertilization, so that the first plane of segmentation (which has been shown by Rauber to furnish the two ancestors of the cells of the right and left sides of the body respectively), has distributed the two idioplasms unequally. This unequal distribution may be seen even when the sexual tendency is harmonious, whenever the peculiarities of the parents appear separated in different portions of the body. One force cannot be regulative, but the interaction of many forces tending in opposite directions is needful to hold the balance near the position of numerical equality. These forces act upon the race. In a given instance, it would be impossible to predict what the result will be, owing to our ignorance of the value of the forces that have been operating, (just as the table of vital statistics can show how many persons are to die during a fixed period, but cannot

point out the individuals). There are plenty of theorists who have tried to teach how sexes could be produced at will, among which consult,

*Die willkürliche Hervorbringung des Geschlechts bei Menschen und Haustieren.* JANKE. Berlin, 1889. pp. 579.

This work is a synopsis of various theories of sex. About 400 pages are introductory to the main thesis, and about 100 pages are devoted to notes supplementary to the introductory matter, which treats of the history of sex and heredity theories from Aristotle down. Then follows an historical section on fertilization and causes of sterility, sections on menstruation, the how, when and where of fertilization, followed by sections on artificial fertilization, stirpicultural and other social developments connected with the relation of the sexes. Further sections on the origin, regulation and differentiation of sex lead to the main thesis, which is, that the mother's influence is represented by male offspring and the father's by female, and that the more finely nervous organization overcomes the more plethoric and determines the sex. This is almost the identical conclusion advocated by Starkweather in his work on the *Law of Sex*, in which typical couples are taken and the sex of their offspring predicted. The weakness in this work lies in the method of treating the temperament. So many factors are taken into consideration, that the data presented by any family whatever can easily be made to substantiate the theory; but when we try to apply the theory in special cases, we necessarily meet serious difficulties in the many positive and many negative quantities, each of unknown value, to be considered. Fiquet, Hanssen, Lehn-dorf, the Talmud, and others agree with the above mentioned authors in believing that sex alternates, and that the stronger of the two factors prevails in the determination; but Düsing has shown that the facts that favor such views are really the outcome of the general laws of sex with reference to nutritive states. If the tendency to alternation could be proved, it would account in a simple manner for the numerical equality of the sexes. A thorough acquaintance with biological facts gives precedence to the principles enumerated by Düsing, and such alternation would itself ultimately rest upon alternations of the nutritive conditions. A census should be taken of the order of the sexes in births, to ascertain if a tendency to alternation exists. Nearly all the facts adduced by the thousand and one theorists in support of various fantastic views are assimilable with the Düsing principles, as for example, the following: artificial fertilization produces males; female slaves produce an excess of females; the longer the pause between births the greater the number of female births; tropical peoples bear more females (this, too, with a desire for males so strong that female infanticide is practiced); the parent of strongest passion (reflex action of vigorous sexual elements) determines the opposite sex. Criminals (who are of strong nature) beget daughters in excess; second marriages produce boys in excess, etc. Some thinkers, like Retzius, affirm sex of the different organs of the body, the endoderm being female, the ectoderm male. Others, like Heincke, go further, and affirm that the right side of the body is male and the left female, so that the union of spermatozoa from the right testicle with ova from the right ovary produces males. Stockton-Hough (*The Laws of the Transmission of Resemblance from Parents to Children*, N. Y. Medical Record, August, 1873) believes in an alternation of the sexes due to the effect of the preceding child in its influence upon the development of the subsequent child. Other authors have held an alternate action of the two sides of the body; but cases of ovariectomy have failed to substantiate their views. Millot and Roth believe that sex is determined by the relative positions of husband and